STATISTICAL PATTERN ANALYSIS OF SURFICIAL KARST IN THE NULLARBOR PLAIN (W. AUSTRALIA)

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PROJECT OBJECTIVES

- To employ spatial statistics to quantify the lateral expression of surficial karst across five 500 sq. km focus areas distributed across the Nullarbor Plain.
- To investigate landform morphology and faults, fractures, and joints as controls on the development of the karst template.
- To use the Nullarbor Plain as an analogue to better understand the distribution of karst in an equivalent subsurface setting.

PROJECT RATIONALE

The Nullarbor Plain is part of the arid to semi-arid portion of southern Australia, located on the Great Australian Bight coast with the Great Victoria Desert to its north. It is the world's largest exposed areal karst and occupies an area of about 200,000 sq. km. As summarized by Miller et al. (2012) and Lipar and Ferk (2015), initial karst development most likely occurred during the warm, seasonally wet climatic conditions of the Oligocene, when sea-level fall exposed the recently deposited Eocene Wilson Bluff Limestone for over ~10 m.y. Re-flooding of the plain marked an end to this initial episode before exposure of the Miocene aged Nullarbor Limestone in the Late Miocene and regional uplift. A second episode of karstification then followed in the Pliocene and Quaternary, which was somewhat inhibited by the semi-arid climate, which became increasingly arid ~1 Ma. Exposure of the limestone terrace resulted in the extensive development of surficial dolines that can be identified from high-resolution satellite imagery (Fig. 1).

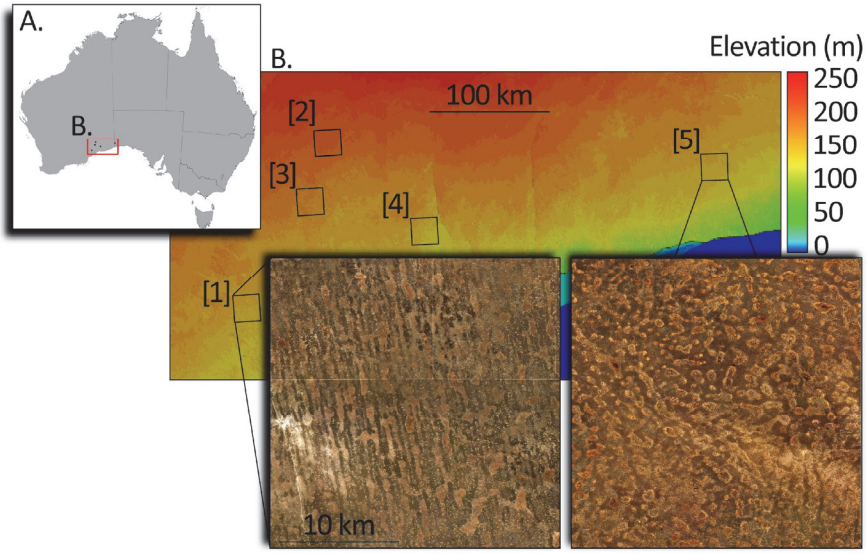

Figure 1. (A) Location of the Nullarbor Plain in S. Australia. (B) Shows the position of the 5 focus areas atop the DTM. True-color satellite imagery for Area [1] and [5] shows the diversity in the expression of surficial karst.

APPROACH

Five focus areas, each covering 500 sq. km, have been selected across the Nullarbor to capture the diversity of surficial karst expression. For each area, m-resolution RGB-IR Pleiades satellite imagery has been purchased along with Digital Terrain Models (DTMs) representing the bare Earth elevation derived from the matching of high-resolution optical stereo imagery. These data will be paired in GIS and the perimeter of each verified doline manually digitized. Following the workflow of Harris et al. (2018), the resulting populations of dolines will be compared within and between focus areas using morphometric indices to quantify, amongst others, size-frequency distribution, separation distance, degree of clustering, etc. If available, the same workflow will be performed on a seismic horizon to facilitate comparison with a subsurface example similarly afflicted with extensive karst. With reference to the available literature (e.g. Webb and James, 2006) and through visual interpretation of the imagery and DTMs, possible controls on the style and patterning of the karst will be explored, as exerted, for instance, by faults and fractures, character of the underlying limestone, and terrain morphology of the selected focus areas.

SIGNIFICANCE

This study is poised to examine the surface topography of a karstified limestone plateau over an area of 2,500 sq. km – a significantly greater extent than has previously been considered. Pairing of high-resolution satellite imagery and a DTM provides the opportunity to investigate the extent and spatial characteristics of surficial karst with a more quantitative, and potentially predictive, approach that will have applicability to other exposed and subsurface karst terrains. Karst-modified hydrocarbon and aqueous carbonate reservoirs are often characterized by extreme heterogeneity, with reservoir compartmentalization commonly attributed to the products of meteoric diagenesis, including dolines, caves, fracture-controlled solution features, vuggy porosity, and collapse breccias. However, the amount of karst overprinting in these systems can vary laterally and its role in influencing reservoir character can range from insignificant to extensive. Our quantitative analysis of the Nullarbor Plain can perhaps aid prediction where karst is, or is not, a dominant factor, and thereby be a potential control on reservoir character in analogous karstified settings.

REFERENCES

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